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**Appendix N**  
**Chatfield Marina**  
**Reallocation Impact Assessment Report**

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# Chatfield Marina

## Reallocation Impact Assessment Report

### Chatfield State Park - Littleton, CO



February 2011

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## 1.0 Executive Summary

JJR was retained by the Chatfield Marina management to assess the potential effects on the existing Chatfield Marina that would result from increasing the Chatfield reservoir pool range. This assessment considers the full range of water levels from low pool to full water supply pool (FWSP). This report has been written to supplement the information documented in the draft Chatfield Reservoir Storage Reallocation FR/EIS, dated September 2010, prepared for the Colorado Water Conservation Board (Reference 1). In addition to evaluating the effects of the normal pool range expansion, the effects of the revised flood frequency predictions are also included in this report.

This report provides an evaluation and inventory of the existing facilities, documents the basic design requirements, and identifies two alternative approaches to modifying the marina and the local environs to respond to the post reallocation condition.

The existing marina presently leases space for its operation. The lease boundary is not clearly delineated between the State Park facilities and the Marina. Therefore, for the purpose of this study, the upland facilities that are primarily associated with the marina facility have been included in the evaluation. All elevations identified in this report are based on those used in Reference 1 as Mean Sea Level (MSL).

Appendix H of Reference 1 documents the expected flood elevations and frequency. The Land Development Guidance at Corps Reservoir Projects (Reference 2) provides upland development guidelines for flood evaluation and is used here as the basis for development of the alternatives. The water level graphics in Appendix 1 of this report show the existing pre-reallocation water level conditions, the “Reefs” alternative water level conditions and the “Islands” alternative water level conditions. The final design for the renovations is not complete. The final design may be a combination of the alternatives presented in the report or it may be a new alternative altogether. This report identifies alternatives to develop an approximate range of costs to be expected as the design progresses. The formal engineering and design process will develop a more accurate opinion of probable construction costs.

The existing Chatfield Reservoir Recreation Facilities Modification Plan (Reference 3) examined some of the conditions related to the reallocation, but did not evaluate the effects of the additional water imposed above the FWSP. These effects have not been adequately accounted for in the cost assumptions listed in the reference 3 tabulations.

The changes in the reservoir conditions documented in this report require significant rebuilding of the marina facility for it to remain functional. Based on the rebuilding requirements, two design alternatives were developed and are documented herein. The design alternatives represent two different approaches to achieving this objective. The “Islands” concepts develops the basin by select excavation and fill distribution and the “Reefs” concept develops the basin by creating a protective reef.

Finally, this report contains both the approximate engineering costs and the potential construction costs



associated with the two explored alternatives. As with any report at this early stage, many factors may occur that will significantly change the final costs. Given the preliminary nature of the alternative development, a contingency has been added to the opinions of probable construction costs.

## 2.0 Introduction

The Chatfield Reservoir was constructed by the Corps of Engineers starting in 1973 as a flood control project. The decision to build the reservoir was the result of the disastrous flood of 1965. The current proposal used in the reallocation studies plans to raise the lake level normal pool from 5,432' to 5,444' MSL. The new calculated pool elevation for the 50 year flood elevation will be 5,467.1' and the 100 year flood elevation will be 5,474.3'.

The original FWSP design range was from 5,423' to 5,432' MSL, although three times (1980, 1983, and 1995) the reservoir flood conditions have reached 5,447'+/-. The evaluation of the impacts of these flood events will be used as the basis for determining the engineering requirements and costs related to keeping the marina business viable and functioning in the post reallocation environment.

This report is based on site evaluations of the current facility and current marina operating conditions, future reservoir conditions predicted in Reference 1, development constraints identified in Reference 2, and our experience in waterfront design and engineering.

Significant effort has been made during the development of the reallocation project to define the impacts on the reservoir, the endangered species habitat and the recreational facilities. This assessment is a more in-depth study of the operations and physical state of the marina to gauge the effect of the reallocation project on the facility.

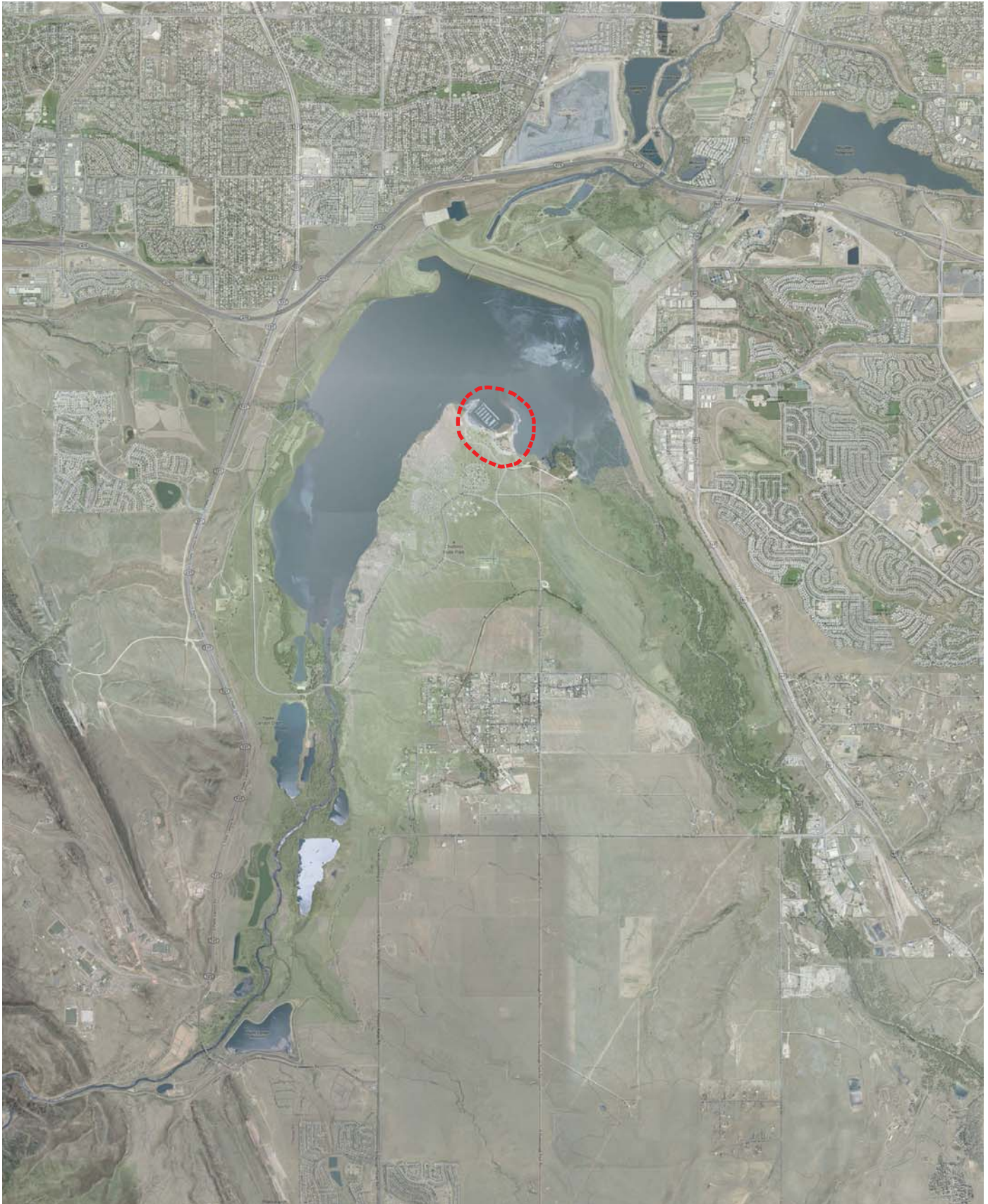
Access to the marina facility needs to be provided not only during the normal range of water elevations, but though the larger range of flood induced water elevations. The range of flood elevations is documented in Appendix H of reference 1; guidance for the development is documented in reference 2; a waiver of some of the guidance is documented in Appendix 6 of reference 3. That waiver addresses the beach house and other facilities, but does not provide guidance for the marina. Utility connections are particularly susceptible to inundation and need to be addressed accordingly. This report will document the proposed changes to the marina to meet the requirements and the intent of the [Land Development Guidance at Corps Reservoir Projects](#) (Reference 2).

This report will:

1. Document the existing marina facility, identifying components and describing their function
2. Identify the constraints to sustaining a marina facility under the reallocation environment
3. Provide alternative layouts that meet the future facility needs, achieving a consistent level of service similar to what exists at the present.
4. Develop preliminary engineering costs and opinions of probable construction costs based on the concept alternatives



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2-1 Chatfield Reservoir - Area of Concern Outlined





3.0 Existing Conditions

The existing design range of water level elevations is from 5,423' to 5,432', although three times since construction of the reservoir there have been flood events where the elevation has reached 5,447'. According to the documentation provided in Appendix H of the draft Environmental Impact Statement (EIS) (Reference 1), water elevation 5,447.2' approximately equates to fifteen feet above the original pool design. Due to the flood events, modifications to the electrical transformer location and the sanitary lift station elevation were made to protect them from the occasional flooding. These modifications raised the equipment to a slightly higher elevation than the 5,447' floods.

JJR undertook an inventory of the existing conditions during a site visit on October 6, 2010. The inventory was supplemented by a review of photographs and interviews with the marina operators, Roger and Linda Perry. Assisting JJR in the inventory and condition assessments was Steven Shoup, a representative of Atlantic Meeco, Inc., an internationally known floating dock manufacturing firm.

In Water Facilities



3-1 Existing Marina Layout

### Marina Docks

The existing floating dock system was built by the operator incrementally over the last 27 years. The dock system consists of welded tube steel frames, polyethylene encased polystyrene floats, and lpe (sustainable Brazilian hardwood) decking. The frames have field welded connections along the mainwalks and hinged connections at finger and secondary platform connections. The shallow nature of the tube frames results in significant flexure (bounce) of the dock system when subject to pedestrian loads. The frames, floats, and decking are all in excellent condition and have been carefully maintained.

The system is more sensitive to wave and wake action than modern factory manufactured systems and requires wave and wake protection along with protection from moving ice.



3-2 Floating Docks Side View

Access to the docks is controlled by keypad accessed security gates. One gate is located on the restaurant platform and a second gate controls access from the fuel dock gangway. Currently there are 334 slips ranging from 25 to 40 feet in length.

The floating picnic platforms are hinged to the south end of the floating marina and behave structurally as semi independent rafts. They provide a place for grilling and picnicking within the confines of the floating marina.





3-3 Floating Docks

#### Dock Anchorage System

The marina docks and the breakwater are held in place using a cable and winch system. The system is anchored to the bottom of the reservoir with a combination of concrete anchors and helix anchors. The anchors are installed and maintained by the operator using a custom spud barge. The 99 anchor point system requires occasional movement and adjustment by the operator. Discussions with the operator reveal that the anchor system, like the dock system has been incrementally expanded and modified over the years.



3-4 Cable and Winch Systems



The anchor system is limited in its current configuration to the normal range of elevations plus occasional flood elevations to 5,472' +/- . The cables associated with the anchor system at the outboard walkway cross the surface of the decking at some locations which result in a significant tripping hazard. The anchorage system in place today was developed by the operator and represents the current system and conditions. Changes in either will probably require a complete reanalysis of the system to meet the new conditions.

### **Recycled Tire Breakwater**

The north and west edges of the marina are vulnerable to wave and wake action from the main body of the lake. Additionally, spring thaw results in significant ice movement on the lake. The marina operator has installed a floating tire wave attenuator to protect the marina docks along these edges. The two part attenuator has an inner barrier attached to the outer edge of the docks. The outer 18' wide mat of tires is anchored independently of the floating docks and is separated by approximately 6' from the inner system on the north and 2' on the west. The anchorage of the floating breakwater is not adjustable.



3-5 Floating Tire Breakwater

The system was popular for marinas in the 1980's as a lower cost alternative to fixed breakwaters or floating concrete structures. Although the system is not very attractive, it has worked very well over the years. Without the protection of the wave attenuator, it is likely that this dock system could experience increased damage from wave and ice impacts.



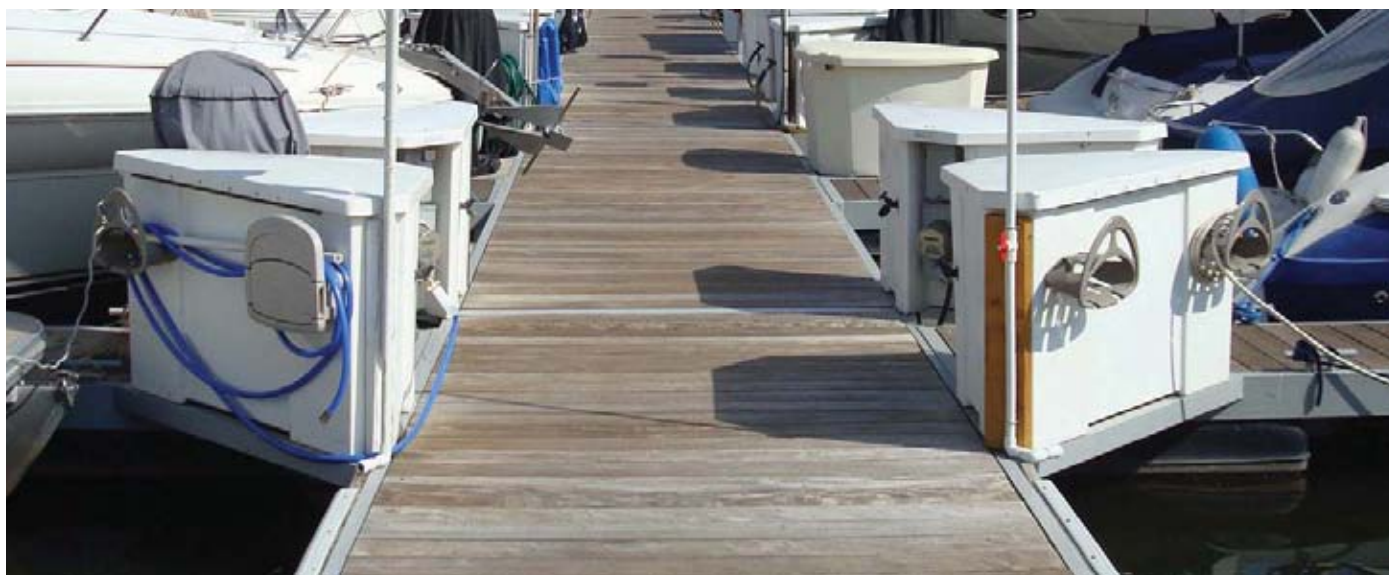
## Marina Dock Utilities

### Electric

Not all of the slips have shore power available to the boaters. Those that have power, docks A and B, have 30 amp 120 V metered service.

### Water

The slips that have power also have potable water supplies. There is no fire protection system in the marina. Fire cabinets and extinguishers are located throughout the marina docks to provide a nominal level of fire abatement capability.



3-6 Dock Utilities

### Sanitary

The fuel dock area includes a Pumpout station and a type 1 dump station. This system is connected to a lift station that discharges the waste to a second lift station located within the restaurant structure. The second lift station discharges the waste upland to a final lift station which conveys the waste into the municipal sanitary system.

### Floating Office/ Restaurant/ Restrooms

The primary building for the marina is a 4,000 sf floating structure supported by a dock section platform with exposed polystyrene flotation. A ship's store/ deli and restaurant includes restrooms and a marina office. Laundry and shower services are not provided in this building. Since the marina is primarily a day use facility, laundry and shower facilities are not amenities that would be used by the boaters.

### Floating Fuel Structure

The 64 sf fuel dock building provides an area for fuel payment transactions and storage of fuel dock related equipment. It is supported by the floating dock system and provides basic service similar to most marinas.



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3-7 Floating Office/ Restaurant/ Restrooms

### Fuel Station

The marina has a 2,000 gallon gasoline only capacity for marine fueling. This is provided by four 500 gallon above ground storage tanks (AST) each within galvanized steel containment tanks floating on dock platforms. Filling of the tanks is accomplished by the tanker man dragging the fill line down the gangway and manually filling each tank separately. The tanks are connected and they feed the two fuel dispensers on the fuel dock. There is no diesel fuel available.



3-8 Fuel Hut

### **Pumpout Facility**

The marina fuel dock facility has the capability to pump out type 3 toilet facilities (holding tanks) and type 1 waste buckets. The facility is in very good condition and is used regularly.

The Pumpout fixture is supplemented by a dock mounted lift station. This boosts the pressure and deposits the waste in a floating platform lift station that discharges the waste to the upland lift station.



3-9 Fuel Station

### **Main Gangway**

The primary access to the floating marina is by a 150' long articulated floating walkway that rests on a concrete accessway during low water conditions. The gangway functions until the water elevation reaches 5440'. No security gates are provided on the gangway, but access is through a gate located on the floating restaurant platform.

### **Fuel Dock Gangway**

A secondary access to the docks is located at the fuel dock. This gangway provides restroom, trash receptacle and parking lot access to the boaters and allows the tanker man a means of access during the fueling evolution. The gangway is relatively short and may become uncomfortably steep during low water conditions.



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3-10 Pump Out



3-11 Pump Out Station



3-12 Lift Station 1



## Upland Facilities

### Restrooms

No upland restrooms are directly maintained by the marina operator. There are two state park restroom facilities near the marina parking areas, one to the south and another just east of the parking lots. Both are plumbed and connected to the sanitary system. Both restrooms are situated below the proposed 5,444' inundation line.



3-13 Main Gangway to Marina



3-14 Gangway Approach

### Parking

The marina facility is serviced by a 258 stall parking lot supplemented by a launch ramp parking facility with 65 trailer spaces and 62 car spaces. Both lots are contained within the bounds of the 5444'elevation affected zone. The lots are in fair condition.



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3-15 Fuel Dock Gangway

### Access Roads

The roads to the marina access both the marina and launch ramp parking lots. With the exception of the immediate approaches to the parking areas, all of the roads are above the 5,444' elevation.



3-16 Upland Restrooms





### **Storage Yard**

The marina has a fenced storage yard at the east end of the parking lot that provides a secured area for maintenance equipment and for paddleboat storage during the off season.



3-17 Existing Parking Lot

### **Stormwater Management**

At the marina parking lot, there are storm grates that collect and direct runoff through a single pipe and discharge it to the lake. No sumps or sediment detention was noticed in the site walk through.

### **Shelters and Picnic Facilities (State Park Property)**

Multiple shelters are located near the marina and seem to be well used. Previous flood events have caused catastrophic failures at some of the structures.

### **Utilities**

Utilities to the marina dockage include, water, power, and sanitary and have been installed in an underwater trench to a location directly below the restaurant platform. The excess length at low water elevations is hidden under the floating platform.

### **Electric**

The electrical transmission lines throughout the park are buried. The primary transformer for the marina is located on an elevated mound south of the marina parking lot at approximate elevation 5,447' although the adjacent land is below the 5444' elevation. The electrical feed to the docks is hidden below the floating restaurant.



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3-18 Marina Storage Yard



3-19 Primary Transformer



### **Water**

Potable water is supplied to the marina from the upland and is connected to the floating restaurant via flexible hoses.

### **Sanitary Sewer**

Marina waste is discharged via a lift station (FM1) from the restaurant building to the upland lift station approximately 1,700'; a second lift station (FM2) discharges the waste off site and into the municipal system another 4,700'. FM2 is located at 5,447' MSL and will be inundated during flood events.



3-20 Lift Station 2

### **Communications**

Telephones are located at the marina office and restaurant. Wireless internet is available throughout the state park, but is a bit spotty. Many boats have satellite dishes.

### **Park furnishings**

Much of the park furnishings are dated and in only fair condition.

### **Landscaping**

Along the lakeward edge of the marina parking lot is a landscaped and furnished park area with a memorial. It provides a pleasant buffer to the parking area. The trees lining the current FWSP of 5,432' are volunteer cottonwoods that have grown since the development of the original flood control reservoir. All of the existing vegetation between the low and FWSP levels will be lost in the post reallocation environment.

### **Signage**

Traffic and wayfinding signage throughout the park meets the current park standards.



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3-21 Picnic Shelter



3-22 Picnic Table

### **South Launch Ramp (State Park Property)**

The South Launch ramp provides an alternative launch point to the larger North Ramp and is used for service and storage access at the marina. The parking lot adjacent to the ramp is separated from the marina users parking area.



3-23 Launch Ramp



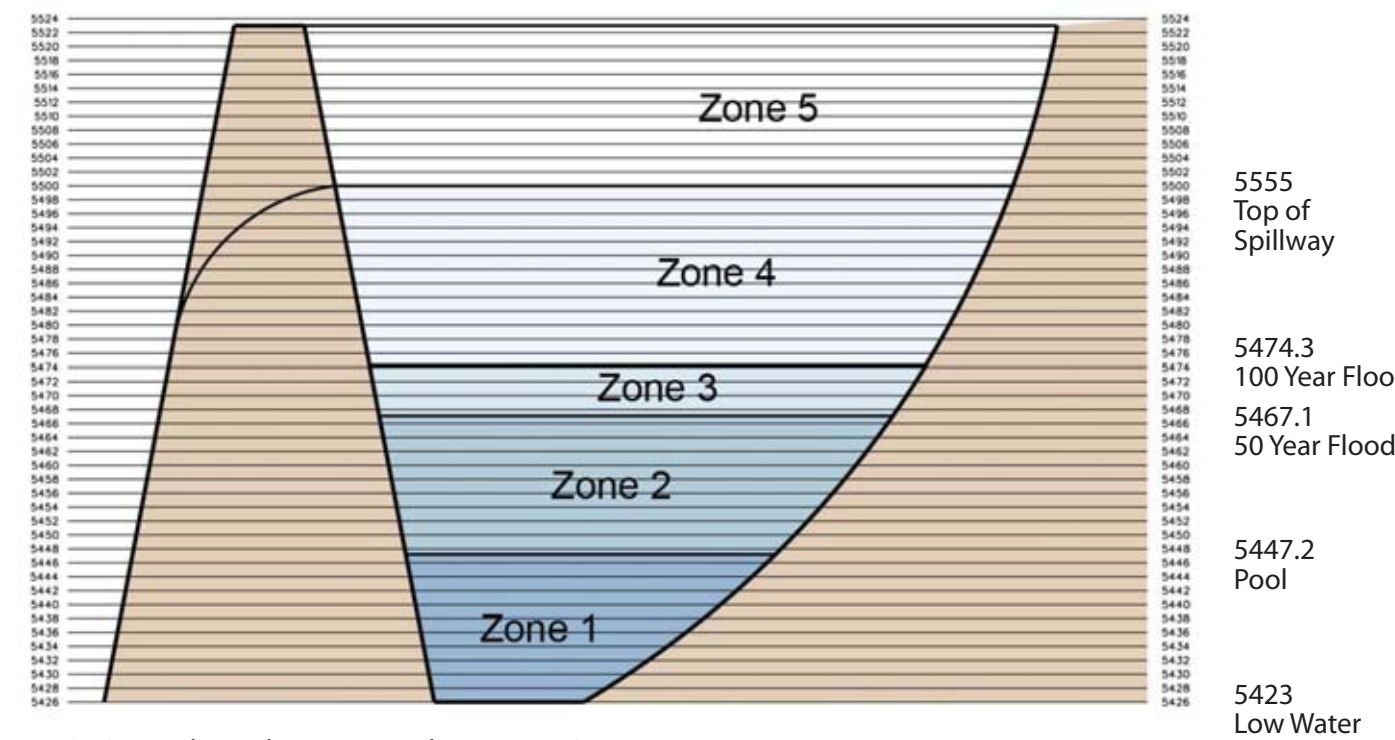


#### 4.0 Reservoir Storage Reallocation Impacts

##### Overview

Based on the draft EIS report (Reference 1), the Full Water Supply Pool level (FWSP) of the post reallocation reservoir will be 5,444' MSL. During flood conditions, and with the addition of rain and snow melt, this elevation will be exceeded on an occasional basis. Water level elevations above 5,447' are predicted to occur every 10 years, while the 50 and 100 year recurrence intervals indicate water levels of 5,467 and 5,473 MSL respectively. At 30' higher than the FWSP conditions, this significantly restricts the options available for marina operation and survivability.

The Land Development Guidance at Corps Reservoir Projects report (Reference 1) dated April 30, 2004 provides assistance for the appropriate siting of facilities such as Chatfield and restricts development below various elevations. The guide is very specific in the types of structures allowed.



4-1 USACE Land Development Guidance Zone Section

In a letter from the USACE Hydrologic Research Branch dated January 29, 2009 a conditional waiver of placing structures in the upper region of Zone 1 (5,447' to 5,453' MSL) was granted for some parts of the State Park, although the marina structures were not included. Other facilities associated with the State Park and Reservoir have not been evaluated for flood damage expectations in the Chatfield Reservoir Recreation Facilities Modification Plan (Reference 3). The plan, prepared by EDAW/AECOM in January 2010, ignores the impact of water elevations above FWSP on the marina related facilities.

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Zone	Frequency Range	Development Constraints	Acceptable Land Uses
1	Up to the 10 % exceedence pool	Subject to frequent flooding, prolonged inundation, sedimentation, and wave erosion. Flood insurance is required for all insurable structures in Zones 1-5.	Structures are not allowed. Recreation and/or nature trails and open recreational fields are acceptable. Generally, camping facilities, primitive or modern, are prohibited. Camping facilities can be considered on a case-by-case basis. An evacuation plan is required for all recreational activities located in Zones 1-5.
2	10% exceedence pool to the 2 % exceedence pool	Subject to frequent flooding, periods of inundation, sedimentation, and wave erosion. Flood insurance is required for all insurable structures in Zones 1-5.	Larger structures are generally prohibited. All land uses considered acceptable in Zone 1. In addition, open floodable, wet flood-proofed structures and field facilities that are functionally dependent on close proximity to water are allowed. Portable concession stands, trails, shade and picnic shelters, backstops, goalposts, fishing piers, etc. are examples considered acceptable. Camping facilities can be considered on a case-by-case basis. All structures and field facilities must be related to authorized project purposes. An evacuation plan is required for all recreational activities located in Zones 1-5.
Zone	Frequency Range	Development Constraints	Acceptable Land Uses
3	from the 2% exceedence pool to the 1% exceedence pool	Subject to periodic flooding, sedimentation, and wave erosion. Flood insurance is required for all insurable structures in Zones 1-5.	All land uses considered acceptable in Zone 2. In addition, closed floodable, wet flood-proofed structures that are functionally dependent on close proximity to water with portable contents are considered acceptable. Larger structures that are functionally dependent on close proximity to water can be considered on a case-by-case basis. All structures and field facilities must be related to authorized project purposes. Camping facilities, primitive or modern, are allowed. An evacuation plan is required for all public use activities located in Zones 1-5.
Zone	Frequency Range	Development Constraints	Acceptable Land Uses
4	1% exceedence pool to the spillway crest elevation	Subject to infrequent flooding, sedimentation, and wave erosion. Flood insurance is required for all insurable structures in Zones 1-5.	All land uses acceptable in Zone 3. In addition, closed floodable, wet flood-proofed structures are permitted that are related to authorized project purposes. An evacuation plan is required for all recreational activities located in Zones 1-5.
5	Spillway crest to 1) maximum reservoir level or 2) to maximum elevation of Corps real estate interests, whichever is lower elevation	Subject to very infrequent flooding, sedimentation, and wave erosion. Flood insurance is required for all insurable structures in Zones 1-5.	All land uses considered acceptable in Zone 4. All structures related to authorized project purposes are permitted. An evacuation plan is required for all recreational activities located in Zones 1-5. The evacuation plan must include people in all cases and structures and contents where applicable.

## 4-2 Zone Description





For the purposes of this study, alternatives were developed that provide normal marina operations from water elevation 5,423' MSL to 5,447.2' (Corps Zone 1), near normal but restricted access to water elevation 5,467.1' (Corps Zone 2), and emergency survival mode to water elevation 5,474.3' (Corps Zone 3).

The normal mode is defined as having no special circumstances or restrictions to customer's full use of the facility. Restricted access mode means that the marina operator may access the site and perform some maintenance and security functions. The 5,454' elevation is mentioned in reference 1 and represents a condition between the 10 year and 50 year probabilities.

Emergency survival mode means that utilities will be secured and that only those functions that keep the marina in place should be attempted.

## **Marina Impacts**

### **Docks**

The existing marina dock system was not designed for the exposed conditions that will occur at full water supply pool level (FWSP). The peninsulas that currently protect the docks will be submerged at water elevation 5,438' and will be totally ineffective at FWSP, leaving the marina dockage exposed. Additionally, the current marina would require re-engineering of the anchorage system to achieve good design practices. The increased variation in water depths require increased anchor scope and a rebalancing of the loadings. Adaptive reuse of the existing docks would require significant improvements of the protecting structures, either the upland peninsulas or the floating breakwater structures. However, even with the improvements to the protecting structures and reworking of the anchorage system, the existing dock system is not designed to respond to the increased water levels .

Replacement of the dock system with a new one will allow for a more robust system that will withstand the more exposed conditions and the increased loadings from wave and ice conditions.

### **Breakwater**

Much of the current wave and ice protection is provided by the existing peninsulas. These peninsulas cease to be effective when the water level rises above 5,438'. The existing floating tire breakwater provides significant wave attenuation control to the north and west for the current normal range of water elevations, partly because of the effects of these peninsulas. Currently, no floating breakwater exists on the eastern flank. With the proposed FWSP, significant additional loads would be imposed on the floating breakwaters. As currently installed the breakwaters are not capable of providing protection for the long term or under the more extreme range of water elevations.

Additionally, since the current floating tire breakwater anchorage system is not adjustable, this system would not function as intended at the FWSP and would be submerged under flood events. A replacement or major reworking of the breakwater would be expected for the new operating conditions.



## Upland Impacts

The peninsulas that currently protect the marina from wake, wave, and ice effects will be submerged under the FWSP and completely ineffective. The current upland zone, between elevation 5,423' and 5,444', will be under the new ordinary high water mark in the reallocation plan which could result in areas devoid of vegetation and appear as beach or open shoreline during periods of low water. The existing cottonwoods and other vegetation that are located below the new ordinary high water mark of 5,444' may be lost unless mitigated otherwise.

The existing upland restrooms will not function at their current location; they must be demolished and rebuilt at a higher elevation. Moving the upland restrooms to the higher elevations increases the distance from the marina and the public courtesy docks to the restrooms to an untenable distance. Therefore, public and marina related restrooms should be located on the floating platform associated with the marina office, store, and restaurant.

The lift station and transformer are currently at approximately elevation 5,451' MSL. The transformer, marina switchgear, water line attachments, and the sanitary lift station all must be relocated to areas above the 50 year flood (5,467.1'). An earlier modification of the height of the sanitary lift station and the main marina transformer resulted from earlier flood events and anticipated future flooding at the existing water levels but did not account for the increased water levels associated with the reallocation. Some underground utility lines, power, water, sanitary will need to be moved above the FWSP line to allow for periodic maintenance. The concepts identified in this report accommodate survival during the proposed 50 year flood period. The Corps' guidance for the reallocation plan is fairly clear on these measures. This report and enclosed concepts falls within the guidance outlined by the Corps of Engineers.

The parking lots, roads and trails all require re-configuration to maintain usability throughout the range of water elevations associated with the reallocation. Removal of the paving material below the FWSP line is recommended. Additionally, consideration for moderate flooding conditions requires raising the grade of roadways and parking areas throughout the marina facility.





## 5.0 Marina Alternatives

During the development of these preliminary alternatives care was taken to replace or relocate the components at a level comparable to the existing facilities. Where changes were made, they were made because of structural, regulatory, or code requirements. The facilities as shown should therefore be considered “in kind” replacements and not “betterments”. The number and sizing of components such as parking lots or boat slips are a direct replacement of those that currently exist.

Two layouts were developed to identify viable alternative designs; the first alternative minimizes excavation, but exposes the marina to higher wave, wake and moving ice loads. The second alternative uses excavated available materials to build higher protective peninsulas. For clarity, the alternatives are named the **Reefs** and the **Islands**, respectively.

The marina and dock system at Chatfield has worked well in its current location with the current protection and the current imposed conditions. With the changes in the water levels resulting from the reallocation, new imposed conditions will negatively impact the marina. When the existing west and east peninsulas become overtopped, new wind generated wave conditions will impact the floating dock system. In addition, ice floes during the spring thaws have the potential to cause additional damage to the dock system.

The two alternatives presented in this report have been developed to provide the same level of service presently enjoyed at the marina once the reallocation has been completed.

### The Reefs

This alternative minimizes the amount of excavated material that is to be placed on the peninsulas. As with the Islands alternatives the parking lots and trails are moved upland to extend their usability through the FWSP and 10 year flood elevations. The minimized excavation means that the marina docks are more exposed to wave forces than the Islands alternative. To protect the marina from the increased exposure, a more effective wave attenuation structure will be required around the perimeter of the marina.

The marina is completely rebuilt to accommodate the reallocation water levels and associated wave and ice conditions and to allow for access under all conditions below elevation 5,450'. Access to the docks is achieved by an ADA compliant multistage gangway and platform system. Used at many marinas throughout the United States, these assemblies allow convenient access and management of the utilities throughout the expected range of water elevations. Utilities to the marina would be routed below the gangways and connected to the floating administration building platform.

A replacement for the existing floating platform based office, convenience store, and restaurant is recommended. The fuel system should be modified to provide USTs above the 50 year flood level. This would simplify the tank fill procedure and would increase safety for the facility. Replacing the fuel system with a system similar to existing was discarded since, the distance from the new roads to any dock mounted AST would be impractical in either of the proposed alternatives.

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The power to the marina requires complete reconfiguration. The most efficient alternative would be to provide 480V or 600V power to a dock mounted transformer and distribute power to the restrooms, administration building, fuel dock and marina docks from that location. The upland distribution transformer will need to be located above the 50 year flood elevation.

The marina docks are reconfigured and the primary restroom facilities for the public will be located on the floating marina admin and restaurant platform. This restroom location will maintain user access during all water level conditions. Additional restrooms will be located at the beach changing structure and upland above the 50 year flood elevation. Roads, trails, and walkways are all moved upland above the 5,450' elevation.

### **The Islands**

This alternative seeks to protect the marina by adding fill to the peninsulas east and west of the marina basin. Material would be excavated from the existing basin and adjacent uplands to build the peninsulas up to 5,448' on the west end and intermittently to 5,448' on the east side. The resulting basin is protected under FWSP conditions and continues moderate protection above that level. Above 5,448' the protection is reduced and the outer docks need to be designed to meet the potential wave loadings.

The marina is completely rebuilt to withstand the flood level wave issues and to allow for access under all conditions below 5,450'. Access to the docks is achieved by an ADA compliant multistage gangway and platform system similar to the system proposed in the Reef alternative. Utilities to the marina would be routed below the gangways and tied in to the floating administration building platform.

The upland region from the low water level to elevation 5,444' at the east end of the marina will be developed into a public beach with a changing room and restroom structure at the foot of the peninsula.

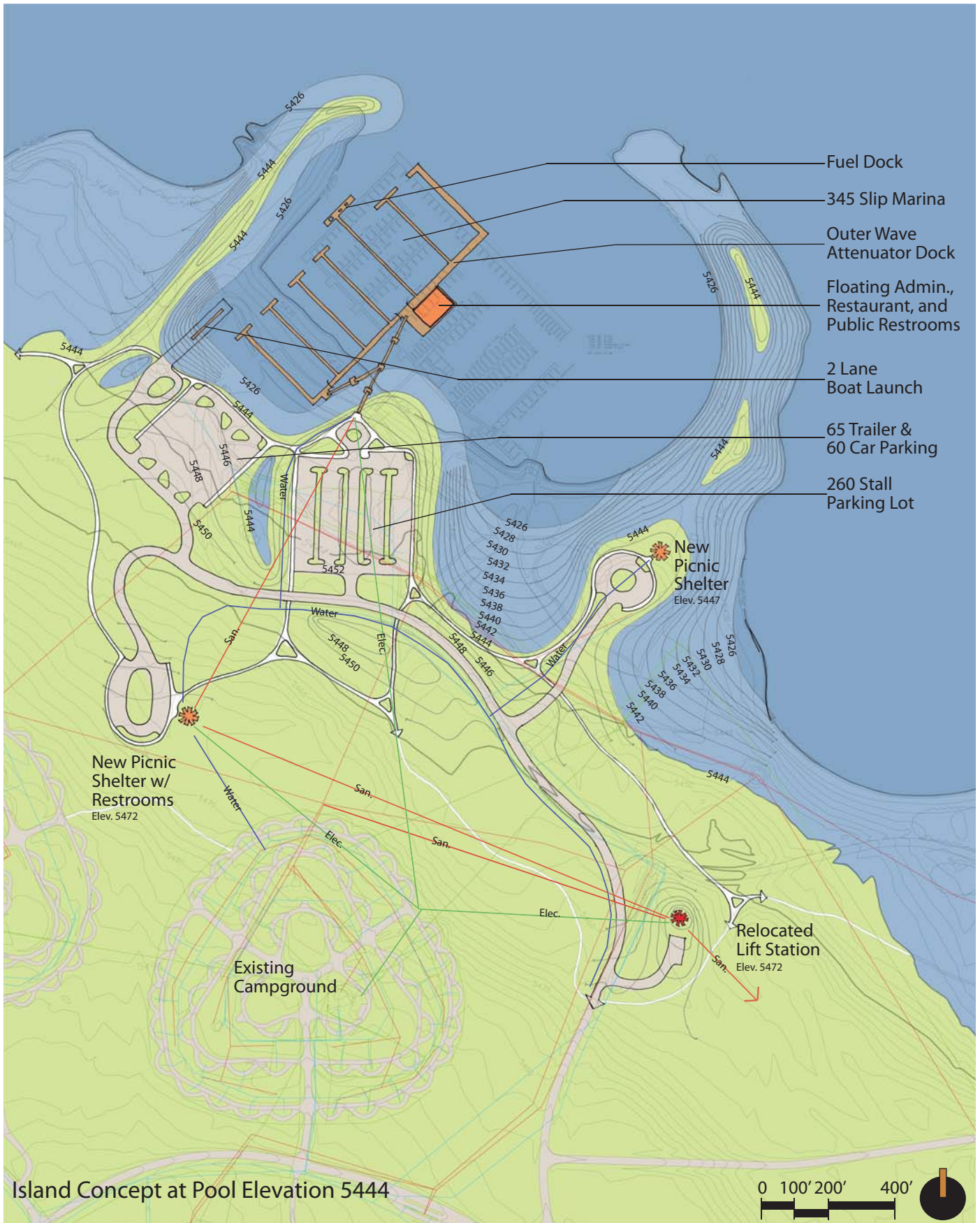
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The marina docks are reconfigured and the primary restroom facilities for the public will be located on the floating marina admin and restaurant platform. This restroom location will maintain user access during all water level conditions. Additional restrooms will be located at the beach changing structure and upland above the 50 year flood elevation. Roads, trails, and walkways are all moved upland above the 5,450' elevation.

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## **Discarded Alternatives**

### **Marina Point Location**

Other locations along the south shore of the reservoir were examined for suitability and discarded.

The proposed alternative location west of Marina Point was discarded early in the evaluations because of the vulnerability to wind and the instability of the existing bluffs.

The northern shore of the reservoir is relatively inaccessible, has a steep (2h: 1v) armor stone embankment and no readily available utilities.

The west and south ends of the reservoir are shallow and would require extreme amounts of cut and fill to develop an adequate marina and upland topography. The South Platte River discharges at south end of the reservoir and this area has relatively flat, low uplands less suitable for development.

East of the current marina location, the reservoir is relatively shallow, has poor upland availability and a less desirable location.

### **100 year flood resistant Upland development**

An alternative was explored to locate the upland parking lots in a location above the 50 year (5,467') or the 100 year (5,474') elevations, but the distance to the marina was too great to be practical. Additionally, the amount of fill required to raise the parking lots above 5,474 and maintain a reasonable distance from the marina would have been cost prohibitive. In addition, the walkway and gangway slopes that would have resulted from this alternative would have been far too steep for comfortable or ADA access to the marina.

### **Upland restaurant, office, restroom structure**

An option that was identified during the interviews involved moving the existing floating building platform in an area that would be dry during normal water levels and allowed to re-float under high water conditions. The adaptive reuse of this platform was viewed problematic for several reasons.

1. The existing platform is floated by exposed polystyrene floats. These floats have little structural integrity under the compressive loads imposed by the concrete platform. The floats have historically had problems with vermin burrowing inside them further compromising their structural integrity.
2. In a post high water environment, any debris caught under the platform would not necessarily be visible from above or from the side. Debris caught underneath could impact the structural integrity of the platform.
3. Utilities currently exit below the platform; a complete reworking of the utilities would be required.
4. The anchoring system required for such a large platform would need to be pile based.
5. The distance to the marina would be too far from the structure.



## 6.0 Moving Forward- Next Steps

### Coordination and Scheduling

The schedule for the reallocation of storage space in Chatfield is understood in general terms, but has not been solidified at this time. However, timely planning and engineering should be undertaken to ensure a continuation of park and marina services once the reallocation is approved.

The initial task will be to integrate the alternatives from this report into the Environmental Impact Statement, allowing the public review cycle to move forward. During that time, the stakeholders of the project need to develop an implementation strategy that allows the preparatory work to proceed in a logical progression. Coordination of the marina rework should include discussions with the following:

- Colorado Water Conservation Board,
- US Army Corps of Engineers,
- Denver Water Board and the other municipal participant's in the water reallocation
- Colorado State Parks
- North Shore Marina Chatfield, Inc.

Negotiation of responsibility for the engineering and design costs is a significant effort in itself. Once the agreements are in place and documented in a Memorandum of Understanding, design and engineering may commence. A preliminary schedule for this work may include:

- 3 months for Responsibility MOU
- Concept Alternative development, Review and Approval, 2-3 months
- Design Development ,3 months
- Permit Application development, 3 months
- Construction Documents, 3-6 months
- Bidding, 1 month
- Construction, alternative dependent, 6-18 months

Concurrent with the Design Development phase and the Construction Document Phase, financing and permit acquisition must proceed.

Design and approval of the changes proposed for either of the alternatives identified herein would take at least a year.

### Engineering and Design Costs

The cost of any design and engineering project is directly related to the number and complexity of components in the projects. The engineering fees for this project have been estimated based on a percentage of construction costs and are shown in the opinion of probable construction costs for the two alternatives.





## Recommendations

The change in the operation of the Chatfield Reservoir will necessitate a major renovation of the Chatfield Marina. The extended range of normal seasonal water elevations will require significant physical and operational changes for the marina. In addition, the dock system that operated satisfactorily within the present water level changes will be vulnerable to the wave and seasonal ice impacts.

- The entire dock system should be replaced with one that will withstand the new environmental loads.
- The marina anchorage needs to be redesigned to accommodate the new range of water levels.
- An ADA accessible route to the marina is required to meet current ADA standards
- The fuel system needs to be located upland and designed for flood conditions.
- Utilities need to be redesigned to meet the new flood elevation expectations.
- Restrooms for marina patrons will need to be located on the floating platform along with replacement marina administration and support facilities.

## Appendices

### Appendix 1- Water Level Graphics Pre and Post Reallocation

Existing Low Water, FWSP and High Water Experience in Lifetime of Reservoir Elevation

The Reefs Low Water, FWSP, 50 Year Flood Elevation, and 100 Year Flood Elevation

The Islands Low Water, FWSP, 50 Year Flood Elevation, and 100 Year Flood Elevation

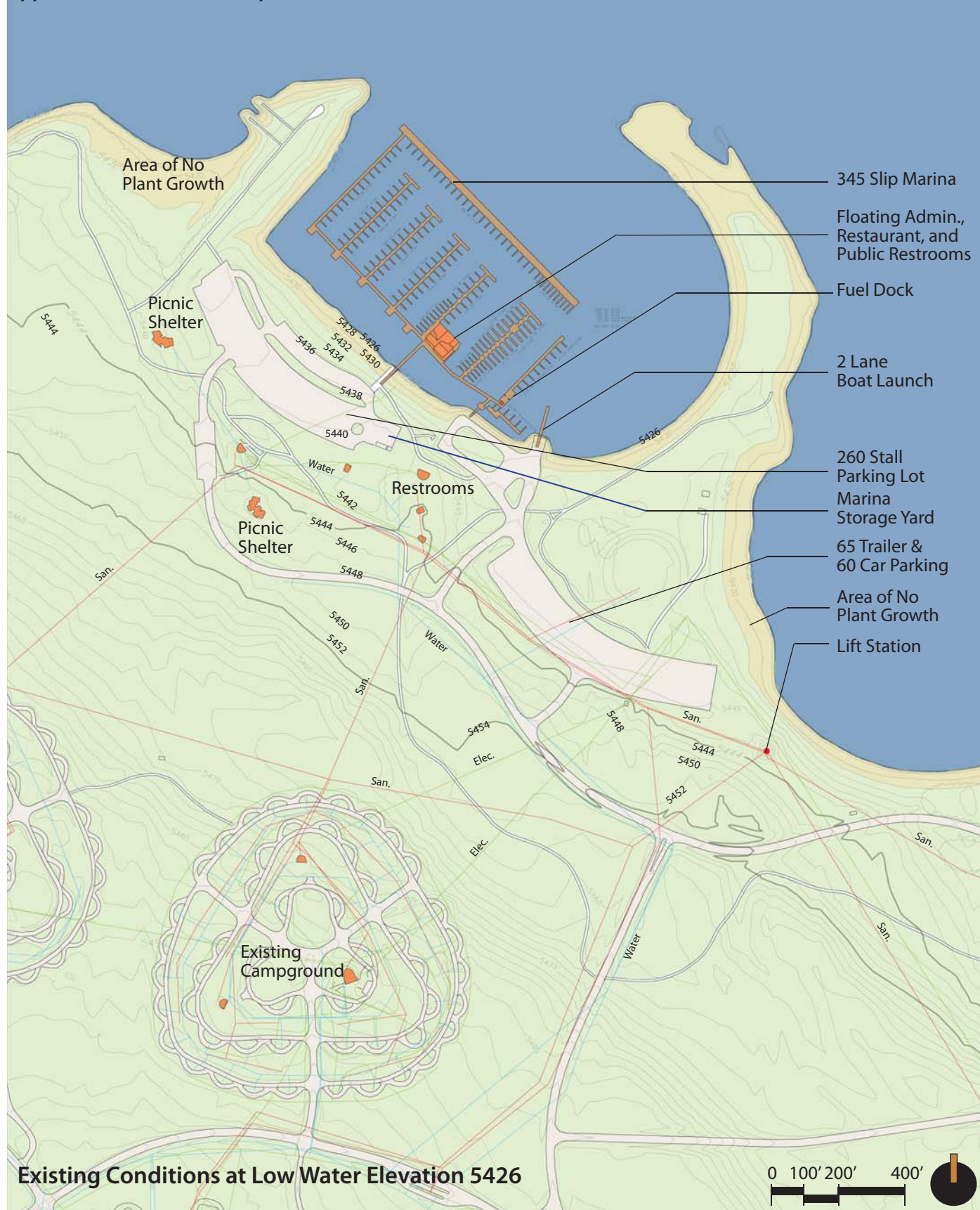
### Appendix 2- The Reefs Opinion of Probable Construction Costs

### Appendix 3- The Islands Opinion of Probable Construction Costs

### Appendix 4- Engineering Costs

# Chatfield Marina Reallocation Impact Assessment Report 2011

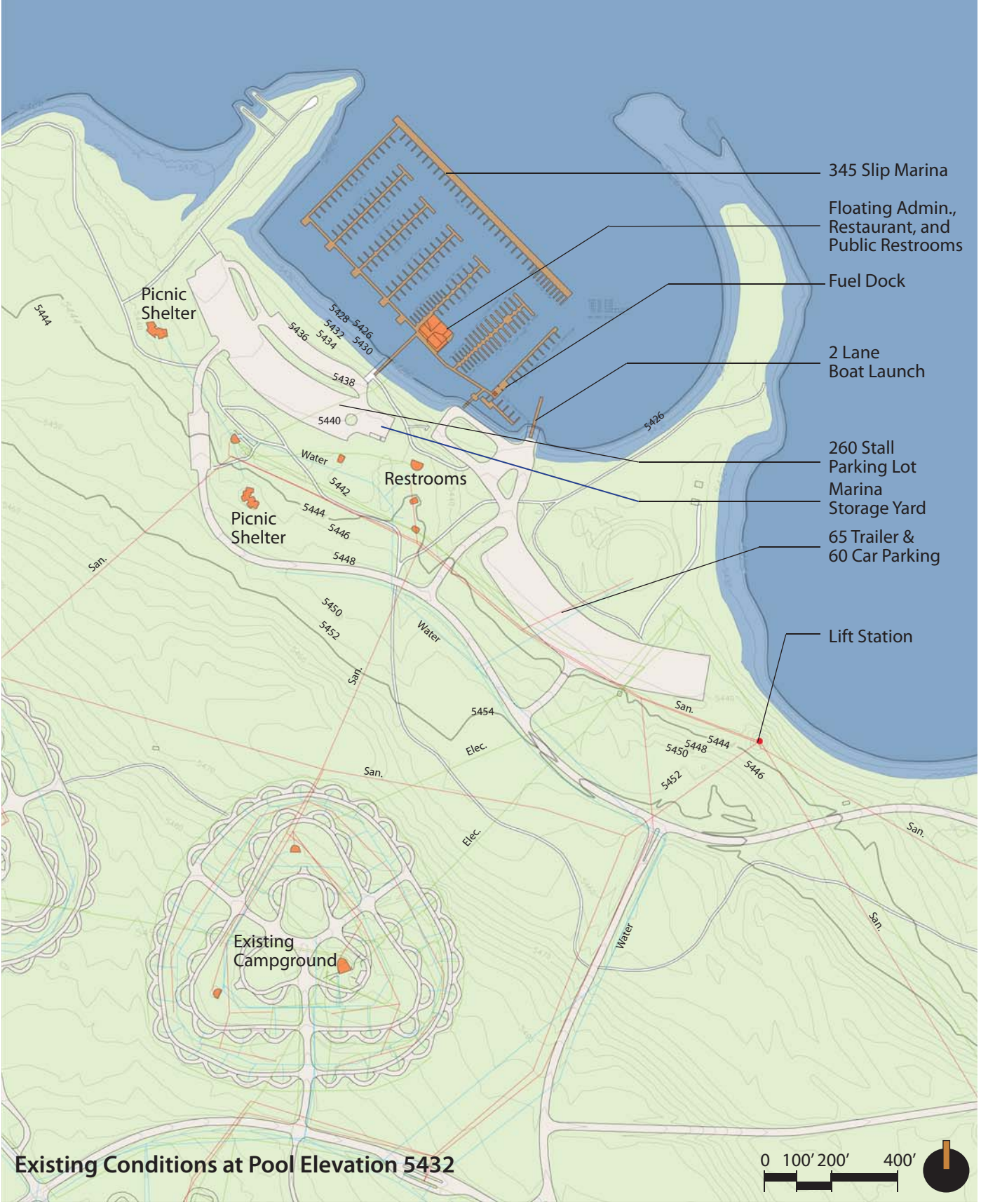
## Appendix 1- Water Level Graphics Pre and Post Reallocation





**Chatfield Marina**  
**Reallocation Impact Assessment Report**  
**2011**

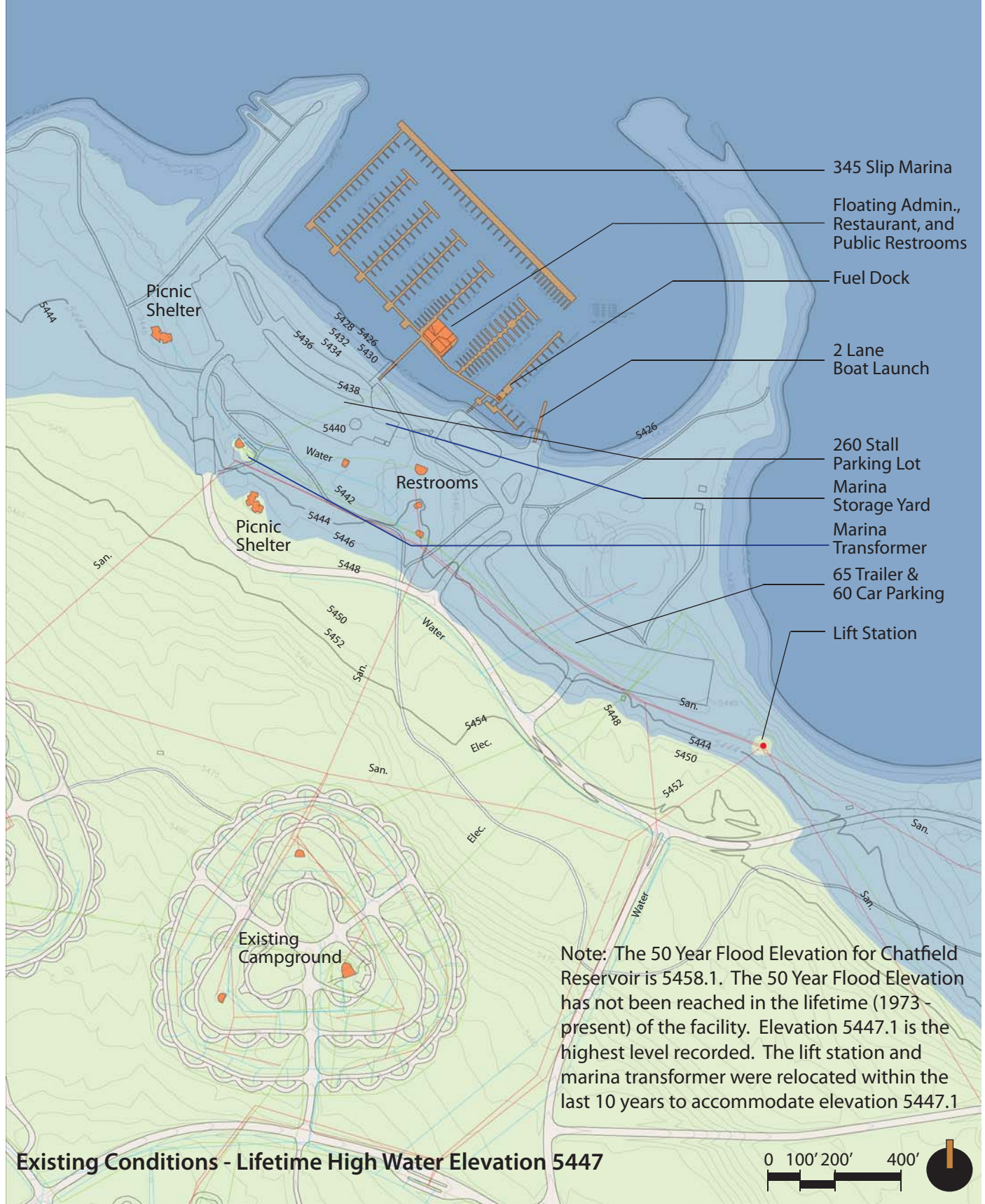
## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

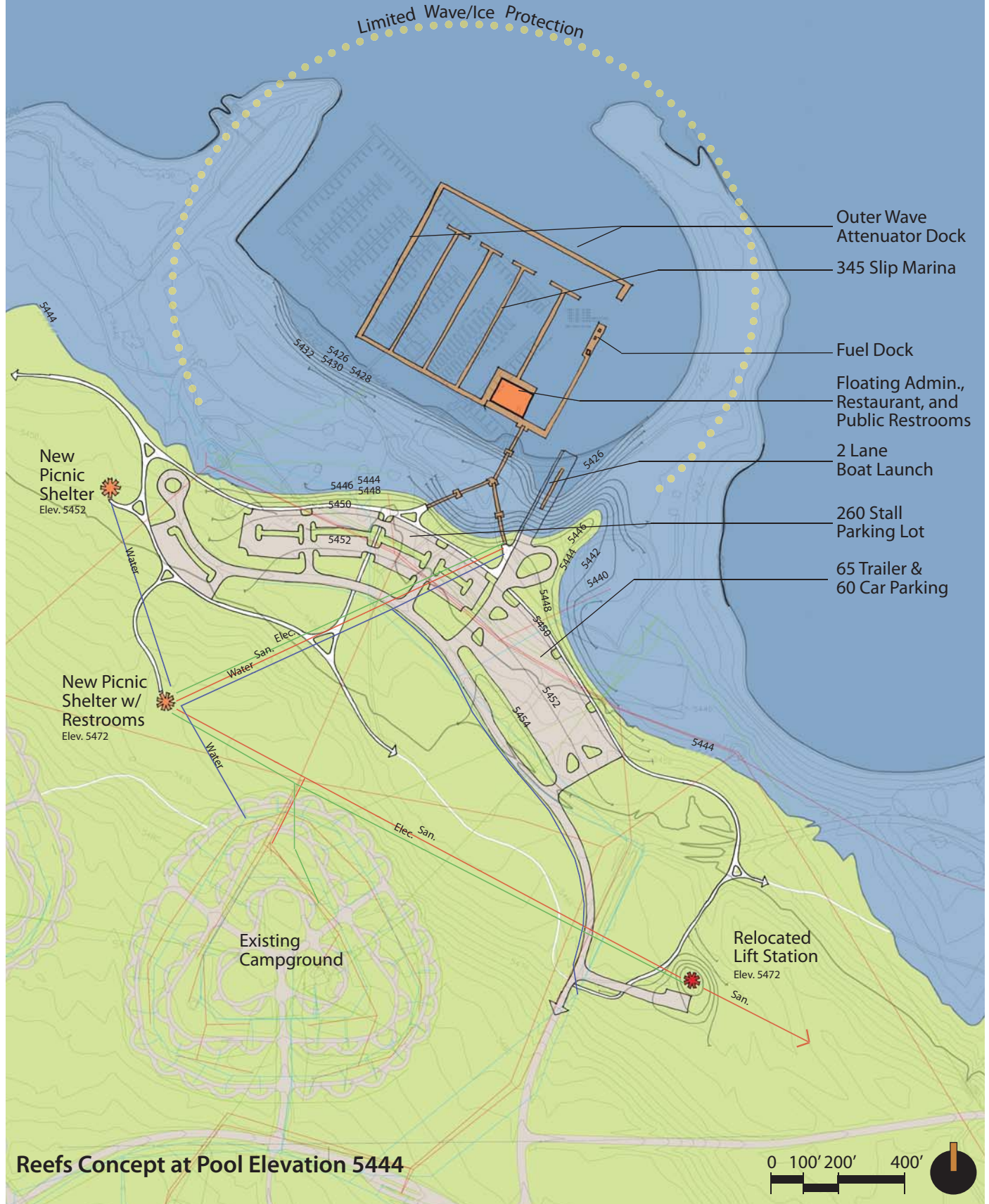
## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

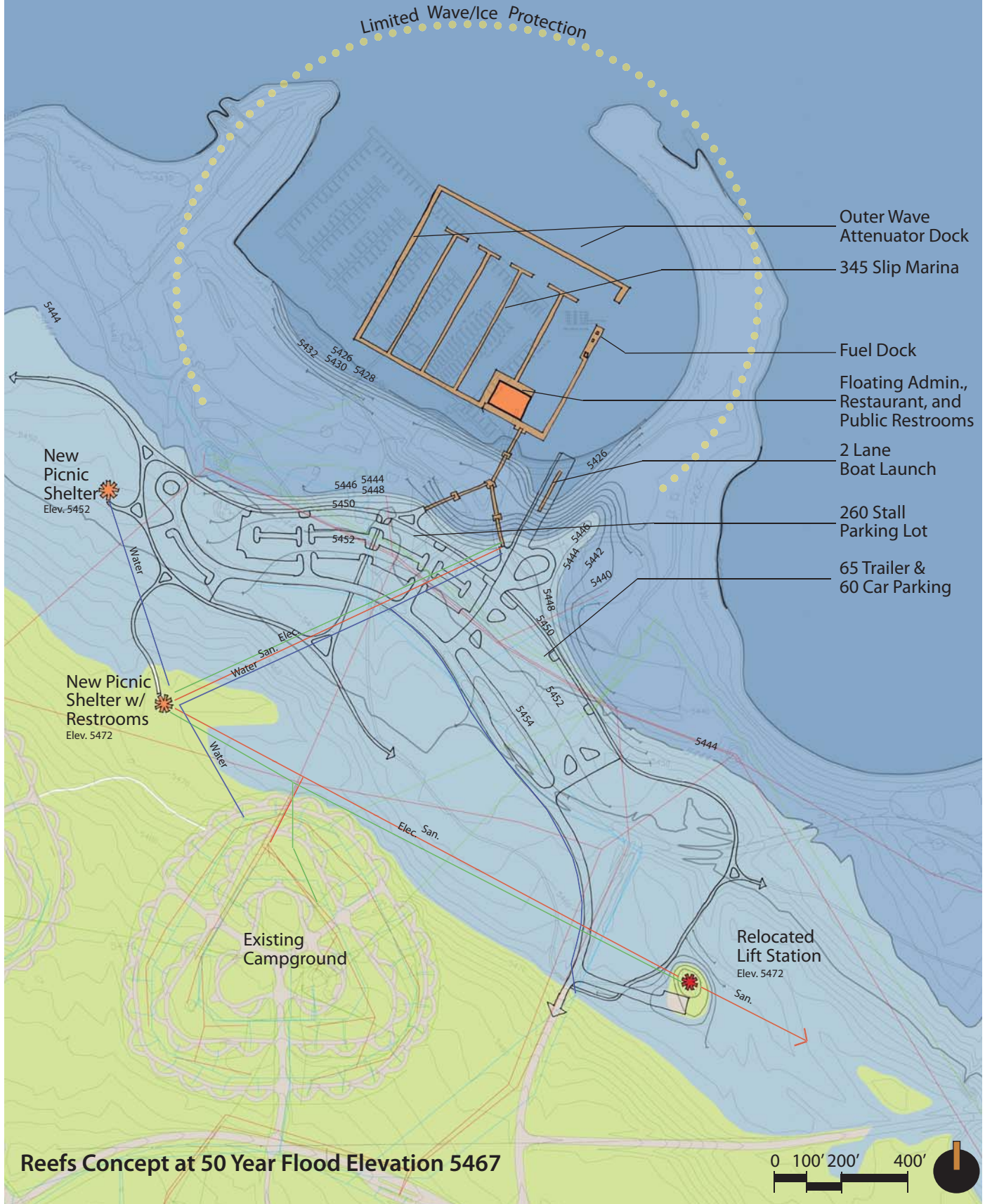
## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

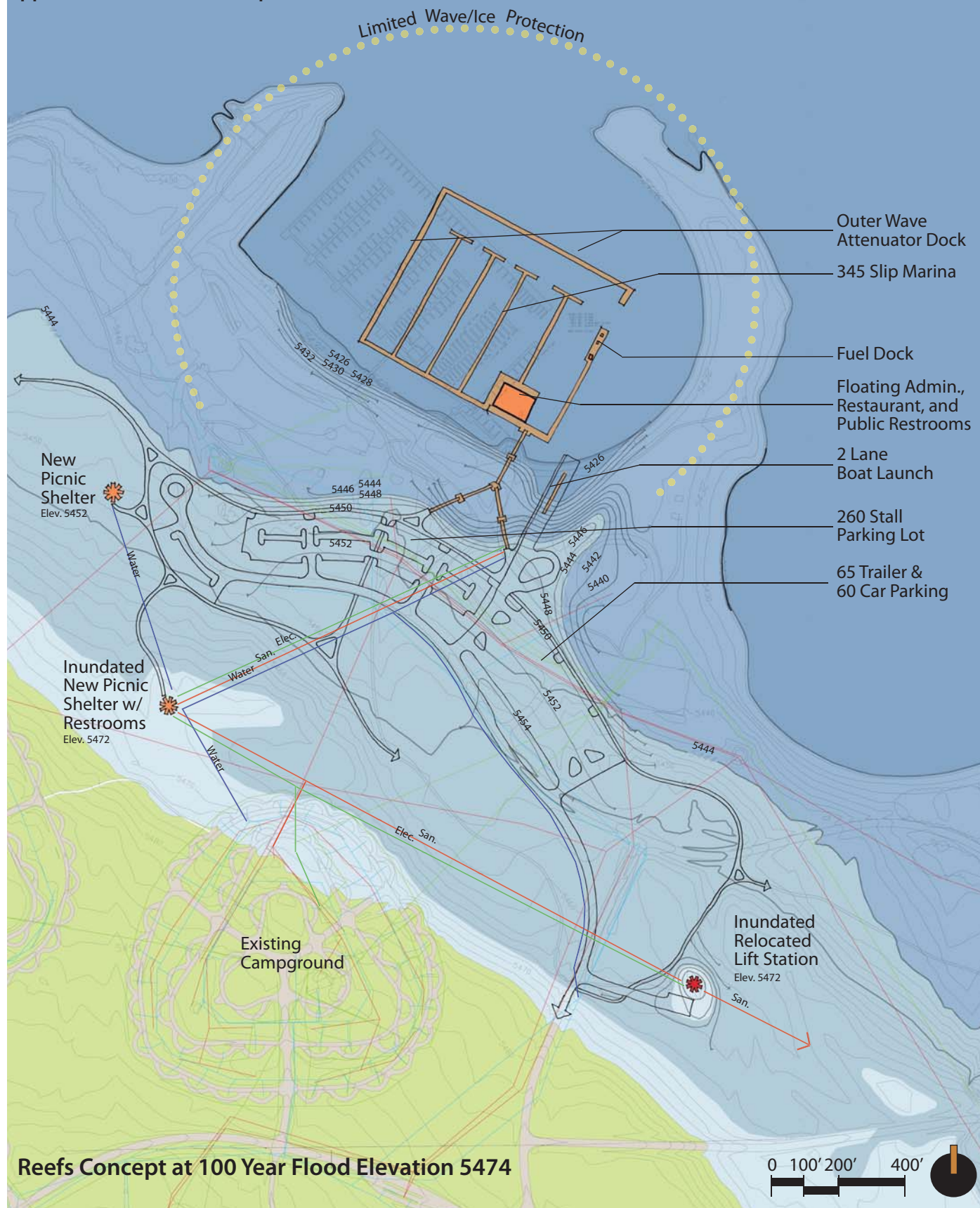
## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

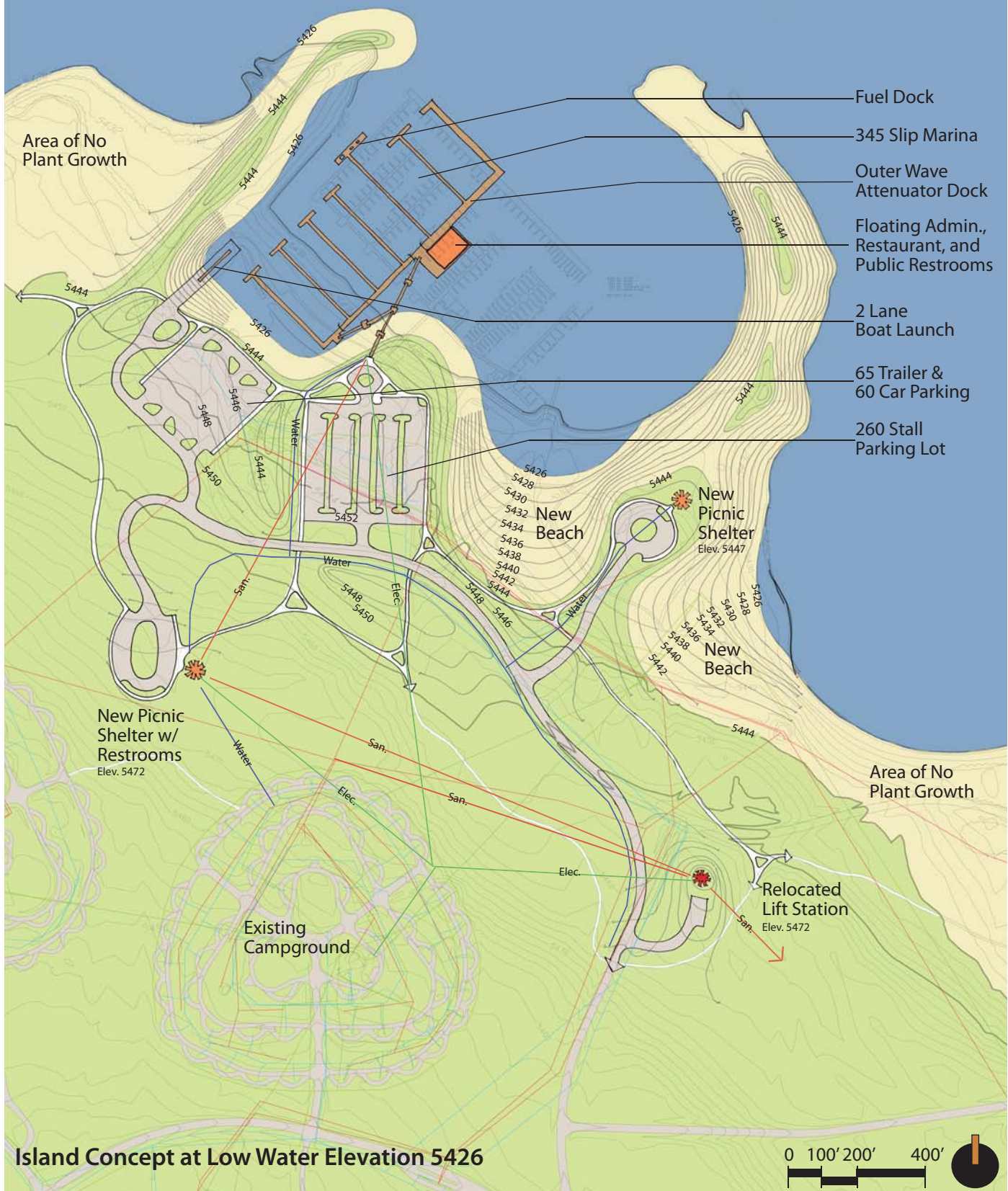
## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

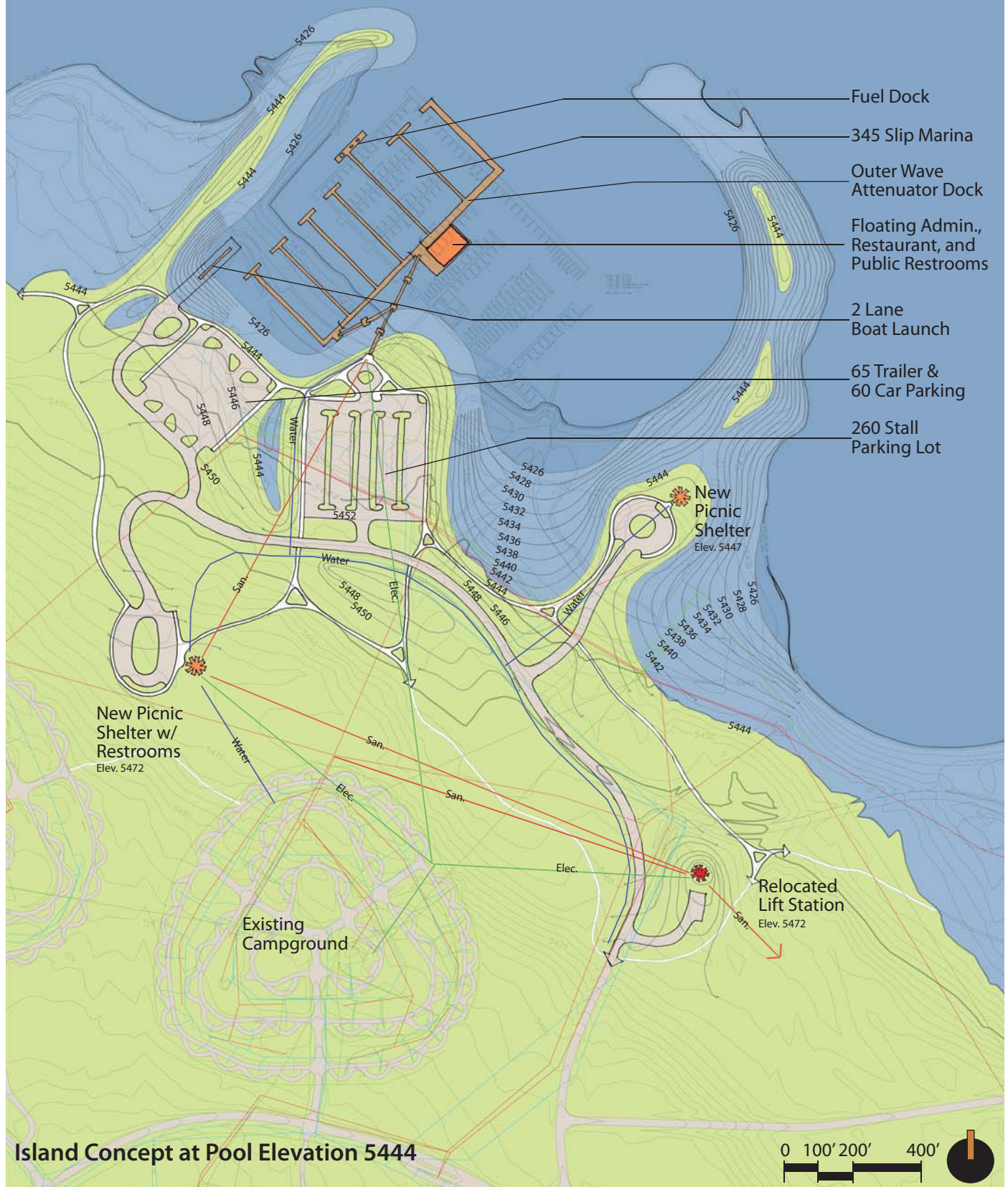
## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

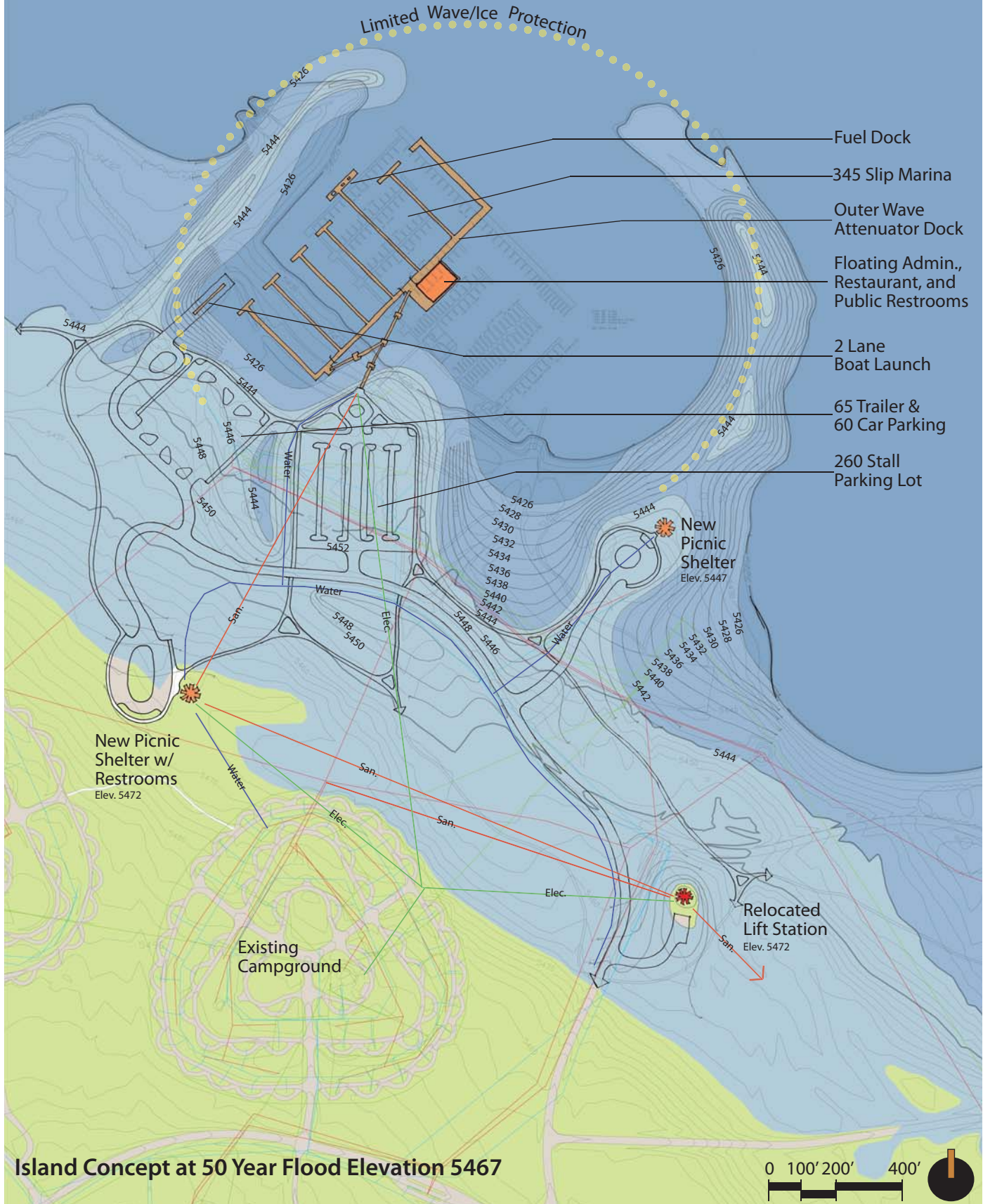
## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

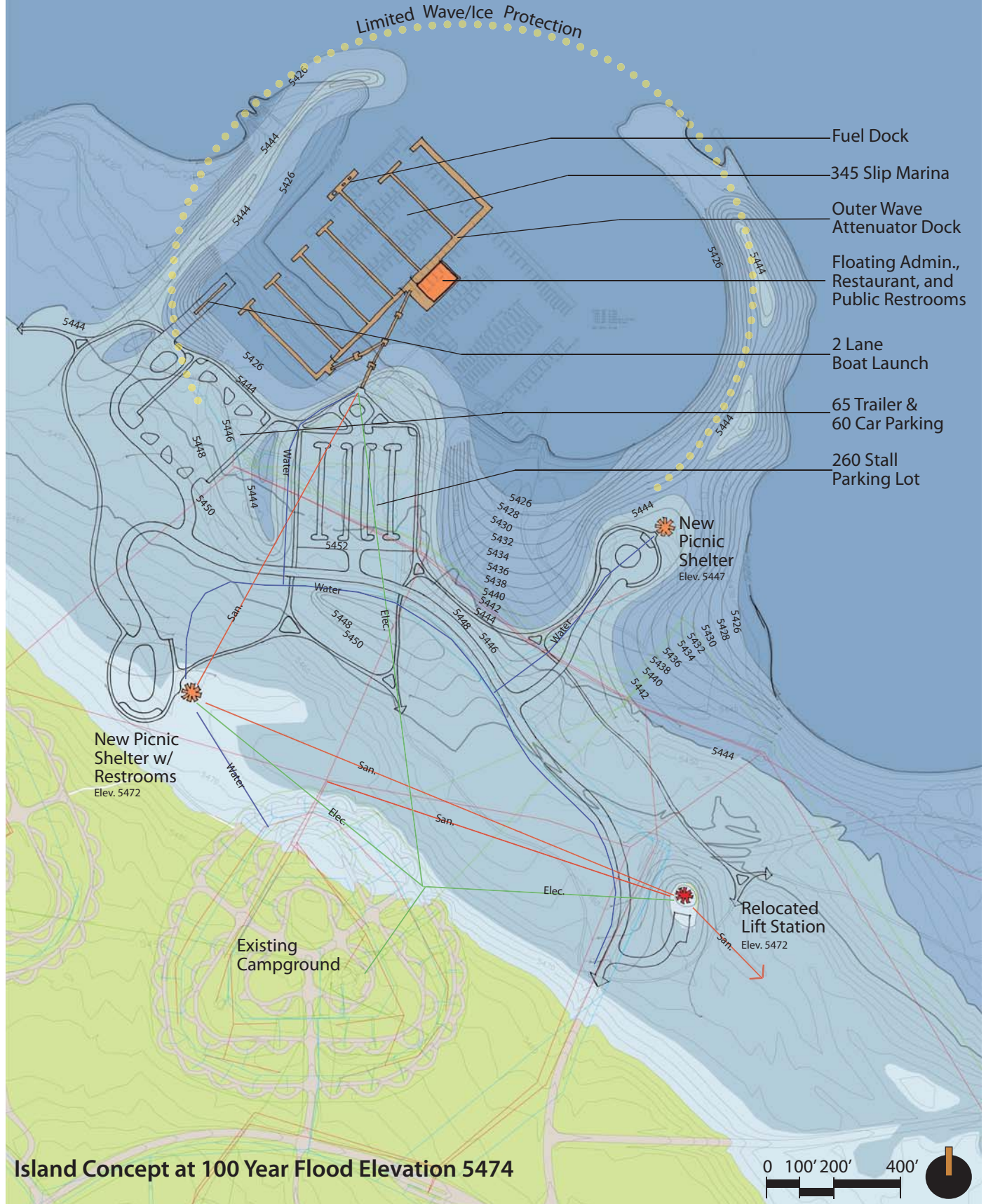
## Appendix 1- Water Level Graphics Pre and Post Reallocation





# Chatfield Marina Reallocation Impact Assessment Report 2011

## Appendix 1- Water Level Graphics Pre and Post Reallocation







# Chatfield Marina Reallocation Impact Assessment Report 2011

## Appendix 2 - The Reefs Opinion of Probable Construction Costs

Opinion of Probable Construction Costs					OPCC TOTAL	\$17,215,965
The Reefs						
50293.000						
Item	Description	Unit	Quantity	Unit Cost	Subtotal	Line Item Total
<b>1</b>	<b>General</b>					\$330,000
	Mobilization/Demobilization	LS	1	\$50,000.00	\$50,000	
	Construction Survey and Layout	LS	1	\$30,000.00	\$30,000	
	Bonds and Insurance	LS	1	\$250,000.00	\$250,000	
<b>2</b>	<b>Demolition</b>					\$595,798
	Clear and Grub	AC	36	\$2,500.00	\$90,000	
	Marina	Slip	340	\$1,000.00	\$340,000	
	Parking lots	SF	30,298	\$1.00	\$30,298	
	Roads	SF	10,000	\$1.00	\$10,000	
	Trails	SF	53,000	\$1.00	\$53,000	
	Utility - Electric abandon in place	LS	1	\$10,000.00	\$10,000	
	Utility - Water abandon in place	LS	1	\$10,000.00	\$10,000	
	Utility - Sanitary abandon in place	LS	1	\$20,000.00	\$20,000	
	Restrooms	EA	2	\$3,000.00	\$6,000	
	Picnic Shelters	EA	4	\$3,000.00	\$12,000	
	Benches and Planters	EA	10	\$100.00	\$1,000	
	Launch Ramp	SF	4,500	\$3.00	\$13,500	
<b>3</b>	<b>Sitework</b>					\$3,507,000
	Erosion Control Measures	LS	1	\$30,000.00	\$30,000	
	Excavation	CY	93,000	\$2.00	\$186,000	
	Placing and Compacting Excavated Material	CY	93,000	\$2.50	\$232,500	
	Dredging - On Site Fill	LS	170,000	\$15.00	\$2,550,000	
	Parking lots	SF	29,000	\$2.75	\$79,750	
	Roads	SF	69,000	\$3.25	\$224,250	
	Trails	SF	38,000	\$2.75	\$104,500	
	Launch Ramp	SF	10,000	\$10.00	\$100,000	
	Launch Ramp - Parking	SF	95,000	\$3.25	\$308,750	
<b>4</b>	<b>Utilities</b>					\$704,000
	Site Electric	LF	3,300	\$15.00	\$49,500	
	XMFR & Switchgear	Allowance	1	\$50,000.00	\$50,000	
	Water Service - Upland	LF	3,400	\$30.00	\$102,000	
	Backflow Preventer	EA	2	\$5,000.00	\$10,000	
	Sanitary - Lift Station	LS	1	\$175,000.00	\$175,000	
	Sanitary Manholes	LF	2	\$3,000.00	\$6,000	
	Sanitary - Upland Services to Lift Station	LF	2,900	\$35.00	\$101,500	
	Sanitary - Force Main Re-Route	LF	7,000	\$30.00	\$210,000	
<b>5</b>	<b>Upland structures</b>					\$340,000
	Restrooms	EA	2	\$100,000.00	\$200,000	
	Picnic shelters	EA	2	\$25,000.00	\$50,000	
	Benches and planters	Allowance	1	\$25,000.00	\$25,000	
	Stormwater management system	LS	1	\$25,000.00	\$25,000	
	Landscaping	SF	1	\$20,000.00	\$20,000	
	Site Furnishings	LS	1	\$20,000.00	\$20,000	
<b>6</b>	<b>Marina Replacement</b>					\$7,565,600
	Docks	EA	340	\$5,650.00	\$1,921,000	
	Gangways	EA	6	\$60,000.00	\$360,000	
	Gangway Platforms	EA	4	\$35,000.00	\$140,000	
	Gangway Abutments	EA	2	\$30,000.00	\$60,000	
	Floating Breakwater	SF	15,000	\$75.00	\$1,125,000	
	Anchorage	LS	1	\$192,100.00	\$192,100	
	Floating Platform	SF	10,000	\$75.00	\$750,000	
	Admin Building	SF	7,000	\$300.00	\$2,100,000	
	Water (D, E, F Only)	Slip	85	\$1,000.00	\$85,000	
	Power (D, E, F Only)	Slip	85	\$3,500.00	\$297,500	
	Power Feeds to marina	Allowance	1	\$200,000.00	\$200,000	
	Sanitary	Allowance	1	\$75,000.00	\$75,000	
	Communication	Allowance	1	\$10,000.00	\$10,000	
	New Fuel System	Allowance	1	\$250,000.00	\$250,000	
					OPCC Sub-Total:	\$13,042,398
					20% Construction Contingency:	\$2,608,480
					12% Design/Engineering/Testing:	\$1,565,088
					Project Total:	\$17,215,965



### Appendix 3 - The Islands Opinion of Probable Construction Costs

Opinion of Probable Construction Costs The Islands					OPCC TOTAL	\$17,319,767
50293.000						
Item	Description	Unit	Quantity	Unit Cost	Subtotal	Line Item Total
<b>1 General</b>						\$355,000
	Mobilization/Demobilization	LS	1	\$50,000.00	\$50,000	
	Construction Survey and Layout	LS	1	\$30,000.00	\$30,000	
	Bonds and Insurance	LS	1	\$275,000.00	\$275,000	
<b>2 Demolition</b>						\$595,798
	Clear and Grub	AC	36	\$2,500.00	\$90,000	
	Marina	Slip	340	\$1,000.00	\$340,000	
	Parking lots	SY	30,298	\$1.00	\$30,298	
	Roads	SY	10,000	\$1.00	\$10,000	
	Trails	SY	53,000	\$1.00	\$53,000	
	Utility - Electric	LS	1	\$10,000.00	\$10,000	
	Utility - Water	LS	1	\$10,000.00	\$10,000	
	Utility - Sanitary	LS	1	\$20,000.00	\$20,000	
	Restrooms	EA	2	\$3,000.00	\$6,000	
	Picnic Shelters	EA	4	\$3,000.00	\$12,000	
	Benches and Planters	EA	10	\$100.00	\$1,000	
	Launch Ramp	SF	4,500	\$3.00	\$13,500	
<b>3 Sitework</b>						\$4,293,500
	Erosion Control Measures	LS	1	\$30,000.00	\$30,000	
	Excavation	CY	223,000	\$2.00	\$446,000	
	Placing and Compacting Excavated Material	CY	223,000	\$2.50	\$557,500	
	Dredging - On Site Fill	CY	172,000	\$15.00	\$2,580,000	
	Parking lots	SF	80,000	\$2.75	\$220,000	
	Roads	SF	60,000	\$3.25	\$195,000	
	Trails	SF	60,000	\$2.75	\$165,000	
	Launch Ramp	SF	10,000	\$10.00	\$100,000	
	Launch Ramp - Parking	SF	95,000	\$3.25	\$308,750	
<b>4 Utilities</b>						\$753,000
	Site Electric	LF	3,100	\$15.00	\$46,500	
	XMFR & Switchgear	Allowance	1	\$50,000.00	\$50,000	
	Water Service - Upland	LF	4,200	\$30.00	\$126,000	
	Backflow Preventer	EA	2	\$5,000.00	\$10,000	
	Sanitary - Lift Station	LS	1	\$175,000.00	\$175,000	
	Sanitary Manholes	EA	2	\$3,000.00	\$6,000	
	Sanitary - Upland Services to Lift Station	LF	3,700	\$35.00	\$129,500	
	Sanitary - Force Main Re-Route	LF	7,000	\$30.00	\$210,000	
<b>5 Upland structures</b>						\$340,000
	Restrooms	EA	2	\$100,000.00	\$200,000	
	Picnic shelters	EA	2	\$25,000.00	\$50,000	
	Benches and planters	Allowance	1	\$25,000.00	\$25,000	
	Stormwater management system	LS	1	\$25,000.00	\$25,000	
	Landscaping	SF	1	\$20,000.00	\$20,000	
	Site Furnishings	LS	1	\$20,000.00	\$20,000	
<b>6 Marina Replacement</b>						\$6,985,600
	Docks	EA	340	\$5,650.00	\$1,921,000	
	Gangways	EA	6	\$60,000.00	\$360,000	
	Gangway Platforms	EA	4	\$35,000.00	\$140,000	
	Gangway Abutments	EA	2	\$30,000.00	\$60,000	
	Floating Breakwater	SF	10,000	\$75.00	\$750,000	
	Anchorage	LS	1	\$192,100.00	\$192,100	
	Floating Platform	SF	10,000	\$75.00	\$750,000	
	Admin Building	SF	7,000	\$300.00	\$2,100,000	
	Water (D, E, F docks only)	Slip	85	\$1,000.00	\$85,000	
	Power	slip	85	\$3,500.00	\$297,500	
	Sanitary	Allowance	1	\$75,000.00	\$75,000	
	Communication	Allowance	1	\$5,000.00	\$5,000	
	New Fuel System	Allowance	1	\$250,000.00	\$250,000	
					OPCC Sub-Total:	\$13,322,898
					20% Construction Contingency:	\$2,664,580
					10% Design/Engineering/Testing:	\$1,332,290
					Project Total:	\$17,319,767





Appendix 4 - Engineering Costs

Chatfield Marina Impact Study  
Opinion of Probable Design Costs

JJR #50293.000

<u>Item</u>	<u>Description</u>	<u>Cost</u>
	Conceptual/Schematic Design (15% of design total)	\$139,890
	Design Development (25% of design total)	\$233,151
	Construction Documents (40% of design total)	\$373,041
	Permitting (2.5% of design total)	\$33,307
	Bid and Award (5% of Design total)	\$46,630
	Construction Administration (20\$ of design total)	<u>\$186,521</u>
	Total at 7% of Net OPCC Estimate based on the "Islands" options costs.	\$1,012,540



## References

1. Chatfield Reservoir Storage Reallocation FR/EIS, September 2010, Colorado Water Conservation Board
2. Land Development Guidance at Corps Reservoir Projects, April 30, 2004, Department of the Army, Corps of Engineers, Northwest Division
3. Chatfield Reservoir Recreation Facilities Modification Plan, January 2010 Prepared by EDAW/AECOM
4. USACE Hydrology Report, Appendix H in the Draft EIS, Table 11, page H-24

Table 11  
Pool Probability - Chatfield, Bear Creek and Cherry Creek Reservoirs  
Comparison of Baseline and With Project Conditions

Location	Conservation Pool <sup>1</sup> (ft msl)	Pool Probabilities (ft msl)				
		2-Year	10-Year	50-Year	100-Year	500-Year
Chatfield Reservoir	5432	5432.0	5437.5	5458.1	5465.5	5479.7
	5437	5437.0	5442.0	5462.0	5469.2	5483.2
	5444	5444.0	5447.2	5467.1	5474.3	5488.5
Bear Creek Reservoir	5432	5560.0	5564.2	5594.0	5606.0	5628.0
	5437	5560.0	5564.2	5594.0	5606.0	5628.0
	5444	5560.0	5564.2	5594.0	5606.0	5628.0
Cherry Creek Reservoir	5432	5550.0	5550.5	5563.1	5567.6	5576.7
	5437	5550.0	5550.7	5563.1	5567.6	5576.7
	5444	5550.0	5550.7	5563.1	5567.6	5576.7

<sup>1</sup> Conservation Pool is for Chatfield Reservoir